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RASPBERRIES.

BY

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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., January 17, 1905.

SIR: I have the honor to transmit herewith a paper on raspberries, prepared by Prof. L. C. Corbett, Horticulturist of this Bureau, and recommend that it be published as a Farmers' Bulletin.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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RASPBERRIES.

INTRODUCTION.

The origin of the raspberry, like that of many plants whose history antedates that of existing civilized nations, is somewhat mystical.

The European berry takes its name from its supposed place of origin, Mount Ida, the Latin terminology making it *idaeus;* and the generic name *Rubus* comes from its close relation to the rose. From the botanist's point of view this relation is very complete, but from our standpoint we can only see a general resemblance in the habits of the two plants and particularly in their defensive armature.

Just what part these thorns play in the economy of nature is hard to say, but certain it is that through cultivation they can be dispensed with, as is the case in our Davison Thornless raspberry and some of the blackberries.

The American raspberries, for there are two types of them—the red and the black—are both familiar to every lad who has passed along the highways of the older States. These berries are aborigines, and, like many other native plants, were entirely neglected by the early settlers until they proved to their own satisfaction that the raspberry of the garden of their native land could not be successfully grown in the new country. They then turned their attention to what Nature had placed before them, and from the wild berries of the clearing have come the American raspberries as we know them to-day.

The name *raspberry*, as used in the United States to-day, embraces four distinct species of plants, three of which are of American origin, thus placing to the credit of our native plants three important and widely cultivated culinary fruits. The two types of fruits represented by these species are known popularly as red raspberries and black raspberries or "blackcaps."

The red-raspberry group, as represented in cultivation, includes not only the native red raspberry but the European red raspberry, or bramble, and a type intermediate between the native red and black

raspberry, which bears a purple fruit and is frequently spoken of as the "purple-cane" raspberry or as the "Schafer group." The red-raspberry group, besides having varieties which produce the characteristic red fruits, has another set of varieties which produce amber or yellow fruit. These horticultural varieties are recognized and are considered distinct sorts, but are not separated botanically into different species.

The black raspberry is distinct both in habit of growth and in the make-up of its fruit. It is recognized botanically as a species distinct from the three which enter into the red-raspberry group. The black raspberry is known to botanists as *Rubus occidentalis*. The habits of this plant and the quality of its berries are such that it has gained an important place in certain sections of this country as a commercial fruit.

The fact that the varieties of the red-berry type have to be marketed from the bushes as soon as ripe confines their cultivation to the vicinity of large centers of consumption, where climatic and soil conditions favor their development. The black-raspberry industry, however, can be profitably and successfully carried on in regions more remote from the centers of consumption, because of the fact that a large proportion of the fruits are evaporated and are sold in a dry state, there being ready sale for them when handled in this way.

RED RASPBERRIES.

As before mentioned, the red-raspberry group includes varieties which bear fruits of various shades of red, amber, yellow, and purple, the last-named division being a hybrid between the red and the black types. The native red raspberry is known to botanists as *Rubus strigosus*. It is quite similar in many respects to the European raspberry, which is known as *Rubus idaeus*, but is distinguished from it by a more slender and open habit of growth, stiff prickles on the bearing, bristly canes, which are brown and somewhat glaucous. It also has thinner leaves and the flower clusters are more open and spreading. The fruit of this plant is bright light red or rarely yellow or whitish and is not produced continuously throughout the season, it having a distinct fruiting period. This type of berry is somewhat more hardy than the blackcap and pushes its northern limits considerably farther toward the Pole than does the black raspberry. One type of this is found in the mountains of Arizona and northward to Alaska.

The hybrid type of the red raspberry is known to botanists as *Rubus neglectus* and is commonly spoken of as the "purple cane" raspberry. This is a very variable group of plants which is the offspring of a cross between *Rubus strigosus*, the red raspberry above mentioned, and *Rubus occidentalis*, the common black raspberry or

blackcap. These hybrids occur both in nature and under cultivation, and the plants have the characteristics of both the red and the black types in that they can be propagated either from root sprouts or layers.

Another type of red raspberry which is cultivated to a very limited extent in the United States, which is not native to our soil, is the common European raspberry known to botanists as *Rubus idaeus*. This plant is sparingly cultivated in the extreme northeastern portion of the United States and again along the Pacific coast from Washington as far south as central California. The most universally cultivated type of red raspberry belongs to the *strigosus* or native red raspberry group.

In habit of growth, the canes of the plants of all three species are upright and the bark is of a light-brown color, the canes themselves being rather slender. The thorns, while numerous, are not formidable, as in the case of the blackcap.

METHOD OF PROPAGATION.

The method of propagating the red raspberry is from root sprouts. One drawback to the cultivation of this group of plants is their persistent habit of throwing up root sprouts wherever a root is broken or uncovered, so that it is only a comparatively short time after planting before the whole area occupied by these plants is covered with young shoots. Persistent cultivation is therefore necessary to hold them within bounds. For purposes of establishing new plantations, root sprouts which are one year old are best suited for making the new plantings. Young succulent sprouts can, under very favorable conditions, be successfully transplanted if a portion of the mother root is carried with the young plant. The safest method, however, is to use the year-old plants rather than the young, succulent ones. The only type of this group which is capable of perpetuating itself through layers of stolons is the purple cane raspberry, *Rubus neglectus*. It has sufficient characteristics of the black raspberry to give it the power of perpetuating itself by stolons.

SELECTION AND PREPARATION OF SOIL.

The nature of the soil upon which red raspberries thrive best is a sandy or clay loam of a glacial drift formation. Naturally, they are found growing at high altitudes and in high latitudes, and are very frequently found upon soils which are rocky and rough in character. Because they naturally flourish upon such soils, it does not necessarily follow that under cultivation they adapt themselves to such soils only. They thrive well upon moderately rich, deep soils and yield largest returns under these conditions.

The preparation of the soil for red raspberries should be the same as for any small fruit, preferably one or two seasons' preparatory tillage in a "hoe crop," which will to a very large extent rid the land of weeds. Such crops as potatoes, beans, cowpeas, and plants of this nature are good preparatory crops.

PLANTING.

The distance to plant will depend very largely upon the purpose for which the plantation is intended. If it is a commercial plantation upon soil which is not especially valuable the plants should be 3 feet apart in the row, and the rows should be not less than 6 feet apart. This will allow of cultivation in both directions for two or three years, and will permit the use of horsepower implements, and consequently much lessen the cost of tillage. On city lots or in a home fruit garden, where it becomes desirable to combine in the same plantation raspberries and other fruit-bearing plants, the distance can be somewhat lessened, but even under these conditions the plants should not be set closer than 2 feet apart in the row and the rows not less than 4 feet apart. Raspberries can be used as fillers between rows of apple, pear, or peach trees, as suggested in Farmers' Bulletin No. 154, if it is desirable to establish an intensive fruit garden.

The most economical way in which to handle the red raspberry in commercial plantations is, after having thoroughly prepared the soil by plowing and harrowing, to lay off the rows with a turning plow, which will make a furrow of sufficient depth to accommodate the young plants. The plants can then be laid along the row at proper intervals, the roots spread out in fan-shape, and the earth hauled over them to a slight extent with a hoe. The remainder of the filling can then be accomplished with a one-horse turning plow. In order to do this most effectively, it is desirable that the roots be spread against the land side of the furrow so that the loose dirt thrown out by the moldboard in opening the planting furrow can be returned by the use of the one-horse turning plow.

In home fruit gardens, where it is not possible to resort to this means, small holes can be opened with a spade, the plant roots spread in the ordinary fashion for planting larger plants, and the earth returned; but in all cases it should be the aim to firm the earth well over the roots of the plants as they are set.

CULTIVATION.

Clean cultivation is necessary with the red raspberries because, as above stated, they are themselves of a weedy nature, and, in order to hold them within bounds, implements which cut all the superfluous

shoots and root sprouts from the cultivated area should be used. During the early life of the plantation it will be found most economical to keep the plants in check rows so that cultivation by horsepower can be accomplished in two directions. Later, however, as the plantation grows older, it will be found advantageous, both in yield of fruit and for economy, to allow the plants to form a hedge or matted row, and to practice cultivation in one direction only. The space between the hedges should be plowed at least once each year, and whether this shall be done in the spring or in the fall will depend upon the locality. In most instances, however, because of the high altitude and latitude in which this plant thrives, spring plowing will be found to be most advantageous, as less injury to the roots will result from deep culture at this season and the plants will be less liable to suffer from winterkilling. The remaining cultivation should be done with an implement which stirs the surface of the soil only to the depth of 2 to 3 inches, so as not to interfere with the young feeding roots which spread through the soil loosened by the plow.

FERTILIZERS.

Comparative tests with stable manure and complete commercial fertilizers have been conducted at the New Jersey experiment station with three sorts of red raspberries, namely, Cuthbert, Marlboro, and Turner. The results of these tests indicate that the liberal use of stable manure (20 tons per acre) will produce large yields of fruit, but when the question of economy enters, i. e., when the manure is purchased and charged against the gross return of the patch, the use of a complete fertilizer—containing nitrogen 4.5 per cent, phosphoric acid (available) 7.7 per cent, potash 13.3 per cent—at the rate of 500 pounds per acre gives a greater net profit at less outlay. The results of the New Jersey tests may be stated as follows: For each dollar invested in stable manure the crop returned $6.09, and for each dollar invested in a complete fertilizer, such as above described, there was a crop return of $27.15. But notwithstanding this great difference in yield, one would hardly be justified in throwing away stable manure and purchasing a high-grade fertilizer. There are other crops, however, such as asparagus, cabbage, etc., to which the stable manure may be added with more profit than to the raspberries.

PRUNING.

Red raspberries require attention to direct their growth and fruit production at two seasons of the year—pruning in the summer, during the growing season, to regulate the height of the canes and induce the formation of fruiting wood for the following season, and pruning during the winter or early spring for the purpose of eliminating the

canes which bore last season, so as to allow all the energy of the root of the plant to be directed to the production of fruit and the formation of the next season's bearing wood.

The summer pruning, which is not generally practiced with red raspberries, consists in stopping the young shoots when they have attained a height of from 18 to 20 inches. This induces the development of side shoots and the production of additional sprouts from the root. Both these types of growth are desirable in order to insure as large a growth of wood as the plants can carry to advantage. This will have to be governed by the judgment of the grower and should be based on the variety, the character of the soil, and the kind and quantity of fertilizer used.

The winter pruning is a process of elimination. All canes which have served their purpose as fruit producers are removed, as are all dead or diseased canes, thus reducing the demands upon the roots of the plant to the wood intended for fruit production.

The advantages of summer pruning are an increase in the area of bearing wood, and strong, low canes which require no artificial trellis or support.

HARVESTING THE FRUIT.

Because of the soft character of this fruit, it can only be successfully harvested by hand picking. Small receptacles holding not more than a pint and preferably those made of wood are best suited for handling this crop. The reason for the use of small receptacles is that the weight of the fruits themselves is sufficient to cause them to settle rapidly and to become mushy if too many are placed in a receptacle, thus destroying their market value as well as appearance. Under favorable conditions, the yield of the better sorts of red raspberries, particularly of the native red and purple cane types, is very large, and where they can be placed upon the market quickly after being picked they are a very profitable crop.

EVAPORATION.

The red raspberry is to a very limited extent dried in an artificial manner by the use of an evaporator in the same fashion as is the blackcap. The demand for dried red raspberries, however, is very limited, and it is only within recent years that there has been a market for this product. The chief use at the present time of the dried red raspberry is in the preparation of fruit juices and marmalades for use in connection with soda fountains. The process employed in the handling of the red raspberry is the same as that described for the blackcap, except that the fruits must be hand-picked and handled much more gently during the process of drying than is necessary with the blackcap.

BLACK RASPBERRIES, OR BLACKCAPS.

CHARACTERISTICS.

The black raspberry, or blackcap, because it lends itself to several methods of harvesting and marketing, is capable of a wider range of commercial cultivation than any of the types of the red raspberry. The black raspberry, under favorable conditions, is a strong, vigorous-growing plant, making canes armed with stiff prickers and bearing its fruit upon shoots of one year's growth—that is, the shoots which

FIG. 1.—A cluster of black raspberries.

grow one year bear their fruit the succeeding spring. The fruit of the black raspberry is borne in dense terminal clusters, as shown in figure 1, and in most varieties is retained upon the plant even after it becomes fully ripe. This characteristic is taken advantage of nowadays to gather the fruits in a very inexpensive fashion. Besides having this character of holding the fruit, the black raspberry is as well adapted for marketing from the vines as is the red raspberry—in fact, it is not subject to the same criticism as is the red raspberry.

The fruits of the black raspberry are more rigid in character and retain their form better. For this reason it is not necessary to use small-sized receptacles for placing them upon the market, quart boxes or cups being usually employed; but, as with the red raspberries, the receptacles should be made of wood. The usual equipment of a picker for hand-picking black raspberries is shown in figure 2.

FIG. 2.—A berry picker and the customary equipment.

The black raspberry has another advantage over the red raspberry for commercial culture in that it is not so weedy in its habit of growth. It does not throw up root sprouts, as does the red raspberry, and for that reason it is more easily kept within bounds. It can also be more easily handled in check rows when desired, but in commercial plantations this is seldom done. Usually the plants are set comparatively close together in rows which are rather wide apart, and cultivation is carried on in one direction only.

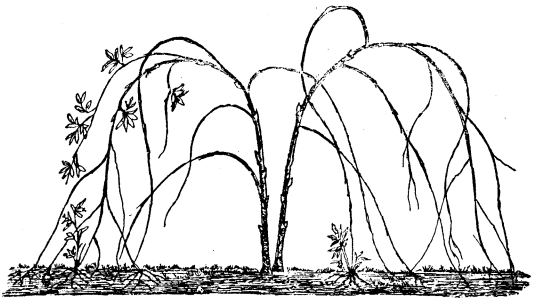

FIG. 3.—Tip-layering raspberries.

METHOD OF PROPAGATION.

As already stated, the black raspberry does not throw up root sprouts, and is propagated only from stolons or layers, as shown in

figure 3. In order to secure new plants the tips of the branches are slightly covered with earth during the month of August, after which they take root readily. The rooted tips are usually left attached to the parent stalk until the following spring, when the branch is cut 6 or 8 inches above the surface of the ground, the roots being lifted, tied in bunches, and stored for use or carried to the place where they are to be replanted.

CHARACTER OF THE SOIL.

The character of soil on which the black raspberry thrives best is a rather rich clay loam. Sandy soils and those which are gravelly, unless well enriched, do not give sufficiently vigorous growth to make commercial plantings profitable. Raspberries grow best on a soil which is naturally well drained, rather than one which is moist. Under natural conditions they are found usually where the soil is somewhat stony in character and provided with good natural drainage.

PREPARATION OF THE SOIL.

The same general preparation of the soil as outlined for the red raspberry is necessary for best results with the black raspberry. Preparatory treatment with cultivated crops in order to rid the land as thoroughly as possible of weeds is desirable. While the raspberry occupies the land for a considerable period of time, it has been demonstrated that instead of becoming unfitted for the production of cereal crops after the raspberries have been removed the soil is capable of returning a good crop of wheat or rye. This is undoubtedly due to the method of cultivation practiced rather than to the fact that the raspberry adds any fertility to the soil.

PLANTING.

The distance at which black raspberries are usually set in commercial plantations is 3 feet apart in rows which are 8 feet apart. The strong-growing, robust varieties will then make a very formidable hedge of considerable width, as is shown in figure 4. The same method of planting as described for red raspberries—that is, opening a furrow with the plow, placing the roots at the proper distances in the row, and covering with a turning plow—is very convenient and satisfactory.

CULTIVATION.

Clean cultivation is equally as desirable for the black raspberry as for the red raspberry, because weeds between the rows interfere with the later operations in the berry field. While cultivation should not be carried on so late in the season as to interfere with the harvesting of the fruit, it should be sufficiently thorough and continued late enough to keep the ground free from weeds.

WINTER PROTECTION.

In some portions of the Northern States the raspberry can only be successfully fruited by giving it some form of protection during winter. One of the simplest methods of affording such protection is to bend the canes of the plant all in one direction along the line of the row and fasten them either by placing earth upon them or pegging them down. The roots are slightly loosened on one side of each plant and the canes are bent over the roots of its neighbor. After the tops have been

FIG. 4.—A general view in a 10-acre berry field.

properly placed a mound of earth is thrown over them. If after cold weather sets in the earth covering is deemed inadequate, additional protection may be provided by a layer of straw, strawy manure, or corn fodder.

FERTILIZERS.

Commercial growers of black raspberries have given little attention to the question of fertilizing their plantations. However, the extensive character of this industry and the small yields from some plantations indicate that this problem demands more attention than it has yet

received. While no careful experiments have been conducted which will warrant a positive statement in this connection, it is safe to say that the use of stable manure in moderate quantities, supplemented by a fertilizer carrying 4 to 5 per cent of nitrogen, 10 to 12 per cent of phosphoric acid, and from 6 to 8 per cent of potash, will prove beneficial. Such a fertilizer, if applied at the rate of from 300 to 500 pounds per acre, should so increase the yield as to make its use profitable. Experiments which have been conducted with the red raspberry indicate that, when it is necessary to purchase manure at ordinary commercial rates, it is more economical to use a high-grade commercial fertilizer than to employ stable manure. Where the grower has home-produced barnyard manure it will undoubtedly be wiser for him to use it rather than not to fertilize at all; but if the barnyard manure can be profitably employed on truck or general crops and it is possible to purchase high-grade commercial fertilizers for the raspberries, the results will undoubtedly justify the substitution of the commercial fertilizer for the barnyard manure.

PRUNING.

Because of its manner of fruit bearing, the black raspberry requires care in its annual pruning; in fact, pruning must be done at two seasons of the year in order to accomplish the best results. The young shoots as they appear from the roots in the spring should be tipped or disbudded when they reach the height of 18 inches. It is better to go over the plantations frequently, making three or four trips in all, in order to tip the canes when they are about the height mentioned, rather than to delay the operation until some of them have reached a height of 2 to 2½ feet. The early pinching or disbudding induces the development of more numerous lateral branches. Shoots which have been allowed to harden and to grow to 2 or 3 feet in height will form few lateral branches. If tipped when 18 inches high, a cane should produce four, five, or six lateral branches. If allowed to attain a height of 3 feet and then cut back to 18 inches, it is probable that not more than two or three lateral branches will be formed; and, since these lateral branches form the fruit-bearing wood of the succeeding season, it is very desirable that the greatest possible number of branches be secured to insure a heavy crop of fruit. It is evident, therefore, that summer pruning predetermines the crop for the succeeding year more than does any other single cultural factor.

The second pruning, which is also important, consists in removing the canes which bore the last crop of fruit. This work can be done at any time after the crop has been harvested, but preferably during the spring following the crop. If the work is done in the spring the lateral branches borne by the canes which developed from the roots

of the mother plant should at the same time be shortened to about 8 to 12 inches in length, as shown in figure 5. From each bud of these short branches annual growth will be made which will terminate in a fruit cluster. Since it is not desirable to stake or trellis the black raspberry in commercial plantations, the short canes have a decided advantage over the long ones in that they more easily support the fruit; in fact, canes which are tipped when more than 2 feet in height very frequently break down or fall over under a heavy load of fruit, while those that are kept at a height of 18 inches usually stand well and hold their fruit off the ground. The early tipping or pinching of the shoots has two advantages: It insures a greater number of lateral branches and it also holds the fruit-bearing canes more erect, thus placing them in a more desirable position for harvesting. Another advantage of early pinching is that it has a tendency to induce the mother root to throw up additional shoots. If the plant is allowed to throw up two or three strong shoots which are allowed to attain 3 or 4 feet in height without check, there is no tendency on the part of the mother root to start other dormant buds into growth. For very best commercial results it is desirable that each crown or mother root throw up from three to five or six shoots annually, to provide bearing wood for the next season. If, therefore, a system of pruning can be followed which will increase the number of shoots from the root there will be a gain in the succeeding crop.

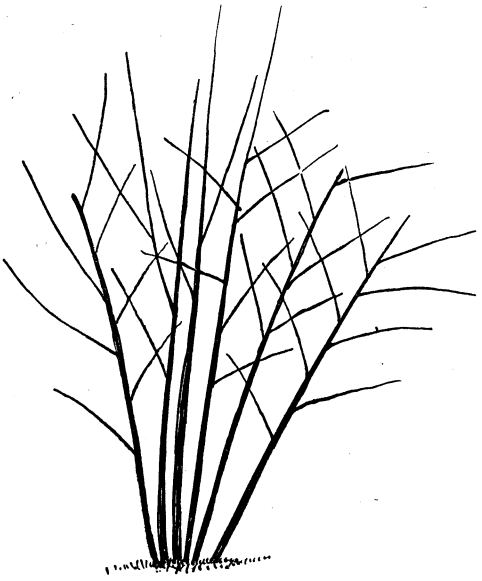

FIG. 5.—Typical raspberry after pruning.

HARVESTING THE FRUIT.

Black raspberries are harvested in two ways. For consumption as fresh fruit they are always hand picked. In fact, many of the commercial growers of blackcaps which are intended for evaporation or drying prefer to hand pick rather than to "bat" the fruit. There are perhaps about as many advocates of hand picking as of "batting," and a grower must decide for himself which, under his circumstances, is most economical.

Hand picking.—The usual method of hand picking black raspberries need not be described further than to say that each picker is known by number and is furnished baskets or cups and a picking stand similar to that shown in figure 2; and, as the baskets are filled and delivered to a receiving clerk, credit is given the picker either in the form of checks or other record by which a memorandum of the quantity picked by each is kept. The methods vary in different localities and with different growers.

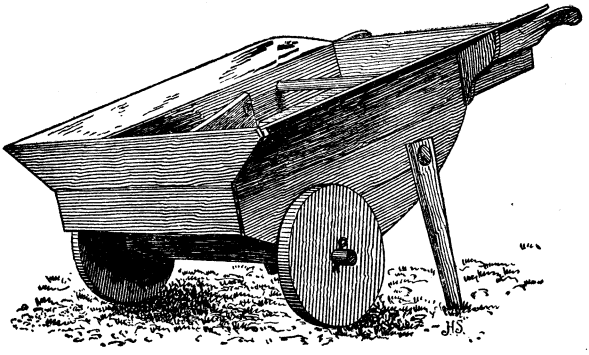

FIG. 6.—The original berry bat.

Mechanical harvesting, or "batting."—In the early nineties a mechanical device for gathering raspberries was brought to the attention of berry growers as a cheap and comparatively satisfactory means of lessening the cost of gathering the crop. This device consisted of a tray mounted as shown in figures 6 and 7, and over the surface of the tray was spread a wire screen against which the berries were beaten by the use of a light paddle, the bushes being bent over the device so that the fruit would fall upon the screen as it was beaten from the plant. The idea was that the screen would allow the fruits to pass through and fall into the tray, while leaves and portions of the vine which might be beaten off would be retained by the screen, and, the screen being hinged at the top, such refuse could be easily thrown off.

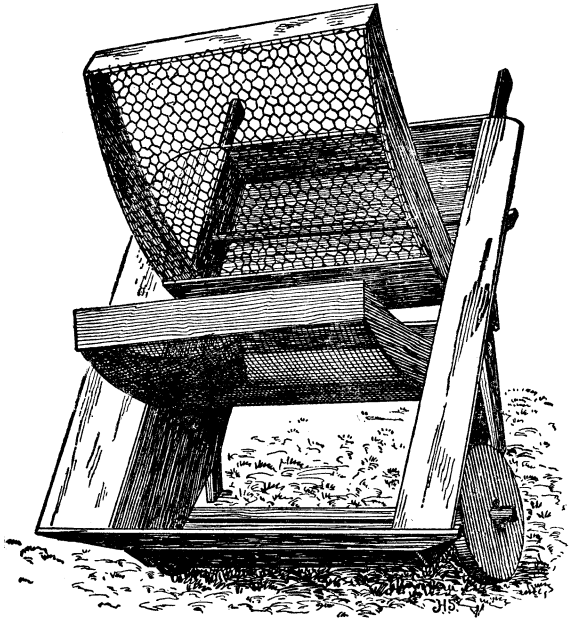

FIG. 7.—Details of the construction of the first berry harvester.

This device was too cumbersome to come into general use. Later it was modified, as shown in figures 8 and 9, to a light, narrow, somewhat triangular frame, covered with muslin. The frame is usually made about 6 inches wide at the bottom, with sides slanting toward the top and tapered from 6 inches in width to about 2 or $2\frac{1}{2}$ inches in width. Across the narrow side a rail is fastened, which serves as a handle for carrying the device, and along the lower end of the tray a light strip is placed, which serves as a runner upon which to slide the device along the surface of the ground. A narrow strip is also nailed across the back of the frame, as shown in figure 9, to act as a protection to the muslin and as a support against which the knee of the operator can be placed to force the picking tray under the plants. After this device, illustrated in figures 8 and 9, has been placed in position, as shown in figure 10, the bushes are drawn over the canvas by a short wire hook and with a light, somewhat curved bat the well-ripened fruits are knocked from the plants on to the muslin and roll gently to the lower end of the tray, where the wider portions of the frame form a receptacle.

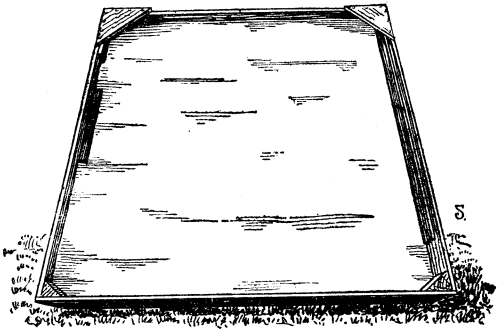

FIG. 8.—The berry bat or harvester as at present constructed.

With a device of this kind one man is capable of picking from 5 to 8 bushels of fruit daily, while the most expert hand pickers can pick only about 100 quarts, or 3 bushels. It will thus be seen that this device is of considerable advantage, because it shortens the period of harvest and allows the employment of a class of labor which could not be employed for hand picking, as the latter is almost exclusively done by women and children, while the work of batting is almost entirely done by men. The drawback to the batting operation is that a small percentage of the berries is lost by bouncing out of the tray as they are forced against the muslin by the stroke of the paddle. This loss,

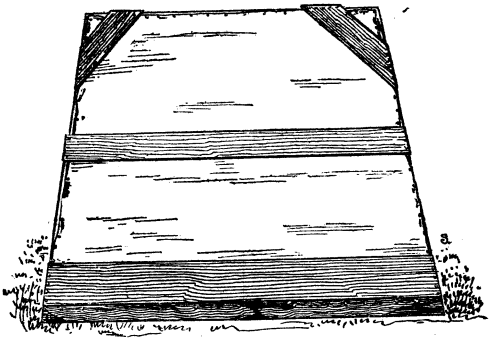

FIG. 9.—Detail of back of device shown in figure 8.

however, is not very great, amounting, perhaps, to not more than one-half of 1 per cent in extreme cases. Some loss also results from the fact that the fruits must be thoroughly ripened upon the plants before the operation begins. This, however, is not great, and the saving over the cost of hand picking will undoubtedly more than overbalance the loss of fruit. The advocates of hand picking, however, contend that there is not so much gain in the use of the bat as would at first appear, because it is necessary that the fruits which are batted be passed over a fan either before or after drying. Hence, some prefer one method and some the other.

FIG. 10.—Berry harvesters at work.

It is necessary that the batted fruits, after being dried, be looked over carefully by hand, as are beans; otherwise, they will not be in fit condition to go upon the market. These two operations, it is claimed, offset the additional cost of hand picking, but, as before stated, each grower will have to determine for himself which method is most economical under his particular conditions. It is obvious that the fruits which are gathered by mechanical means will not be suitable for use as fresh fruits. The batting of raspberries is never practiced except upon fruits which are to be evaporated.

Figures 11, 12, and 13 illustrate a modification of the device shown in figures 8 and 9, which is claimed by the inventor to possess some advantages over the other form. As all these devices are homemade affairs, both plans are presented in order that both may be given a test, which is the only true way of determining their merits.

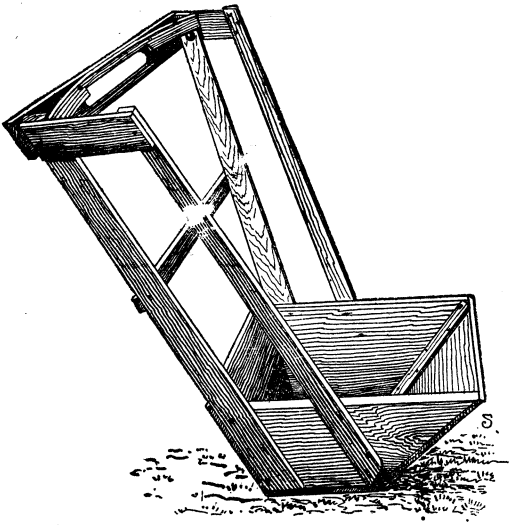

FIG. 11.—A modified form of the modern berry harvester.

CURING RASPBERRIES.

EVAPORATION.

The use of heat, either from the sun or from some artificial source, for the purpose of drying the fruits has made the raspberry an important commercial product in certain sections of the United States. Regions which could not profitably engage in the growing of this fruit were its sole use to be found as a fresh fruit upon the market can now safely undertake its cultivation. While the sun drying of raspberries has been practiced as long as the raspberry has been used for culinary purposes, the art of drying it with artificial heat is a comparatively recent commercial development.

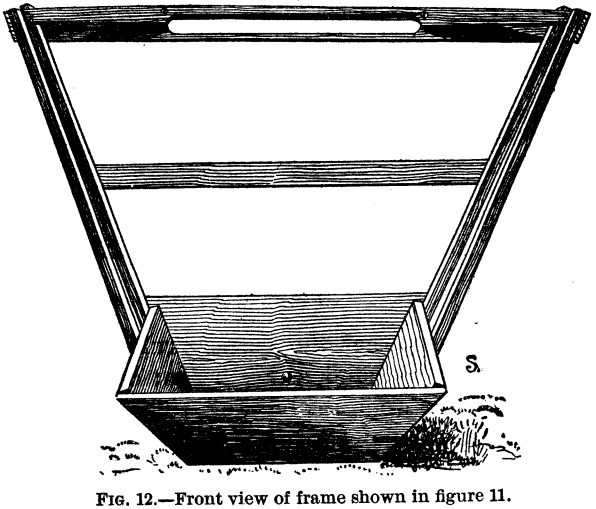

FIG. 12.—Front view of frame shown in figure 11.

The artificial process of drying under a high heat has an advantage over sun drying in that the product can be obtained much sooner and is of a more desirable quality. Evaporated fruit of the

highest quality loses only a small percentage of its juices. The heat is sufficient to sear the outside of the fruit by breaking down its cellular structure and giving it a dry, somewhat resistant surface, which has a tendency to keep the interior portion much more moist and palatable than is possible under the slow operation of sun drying. With partially ripened fruits, such as peaches, apples, apricots, prunes, etc., which are dried under high heats, the process becomes one of transforming the starches into sugar, or, in other words, a quickening of the ripening process. This, to a certain extent, is accomplished with the raspberry, but, as its fruits are usually thoroughly matured when they go to the evaporator, it is likely that there is much less of a chemical change in the raspberry than in the case of the apple. The improved quality of the product from the evaporator not only adds to its commercial value but increases the income of the producer, because there is less loss in weight in evaporated than in sun-dried fruit. In other words, the yield from a given area in evaporated fruit is somewhat greater than the yield from the same area in sun-dried fruit. These features, together with the rapidity with which the operation can be carried on, are considered of sufficient advantage to warrant growers of raspberries in erecting evaporators at considerable expense.

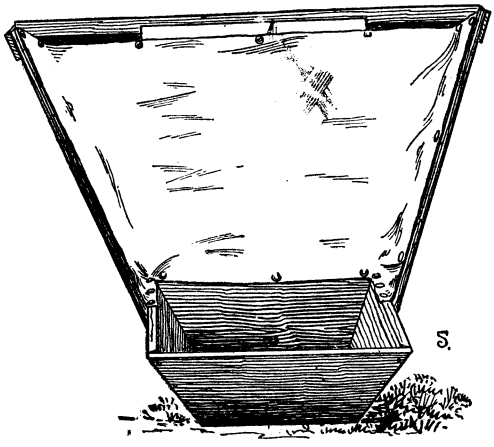

FIG. 13.—Completed harvester after the plan shown in figures 11 and 12.

TYPES OF EVAPORATORS.

There are two distinct principles on which evaporators are constructed—one using hot air as the means of drying the fruit, while the other uses the indirect means of producing an air current from heated steam pipes. In both instances the primary source is the same, but in one the air is heated by being passed over a radiating surface like that of a hot stove, while in the other case the current of air is passed over heated steam pipes. There are also three important types of construction, namely, the shaft or flue, the cabinet, and the hop kiln.

Shaft or flue evaporator.—The shaft or flue evaporator is shown in figures 14 and 15. This device consists of a building which is practically three stories in height. The basement story contains storage rooms for fuel and gives space to the heating apparatus, which is usually a hot-air furnace or large stove. It is a common practice to install a heating device for each shaft or flue, as illustrated in figure 15 (at the left), which shows a cross section of the building.

The furnace is provided either with a jacket of metal which is properly insulated, or with a brick wall which provides an opening for the entrance of air from the outside, the wall usually being carried up to the first story. On top of the brick wall the shaft proper is constructed. The shaft is built of dressed and matched lumber, and extends from the floor of the second story through the third story and out of the roof. Above the roof it is drawn in so as to assume the form of an inverted cone. These shafts are usually 3½ or 4 feet square, inside measurement, and are provided with a lifting device operated by a lever, or by a "bull wheel," which enables the operator to lift by mechanical means the entire charge in the shaft at one operation. The necessity for this lifting device is that the screens which carry the fresh fruits are placed in the flue, or shaft, at the bottom, about 18 inches above the floor of the second story. The screens are usually 3½ or 4 feet square, and are made of 1 by 1¼ or 1½ inch stuff,

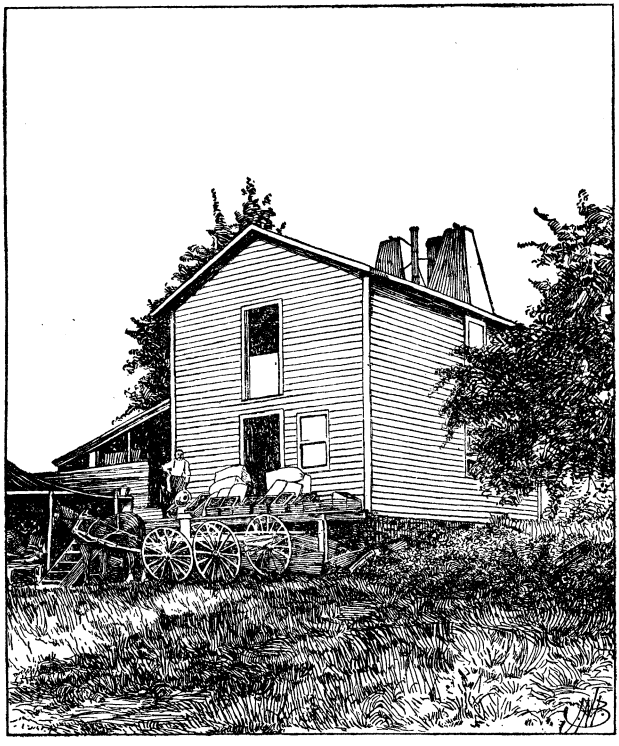

FIG. 14.—Exterior view of a flue evaporator, showing receiving platform.

sometimes in such fashion that they can be used either side up. The fresh fruit is spread upon these screens to the depth of 1 or 1½ inches, the larger screens carrying about one bushel of fruit.

During the drying process, when everything is working favorably, a screen carrying fresh fruit can be placed in the bottom of the shaft every fifteen to eighteen minutes, but after the shaft becomes filled,

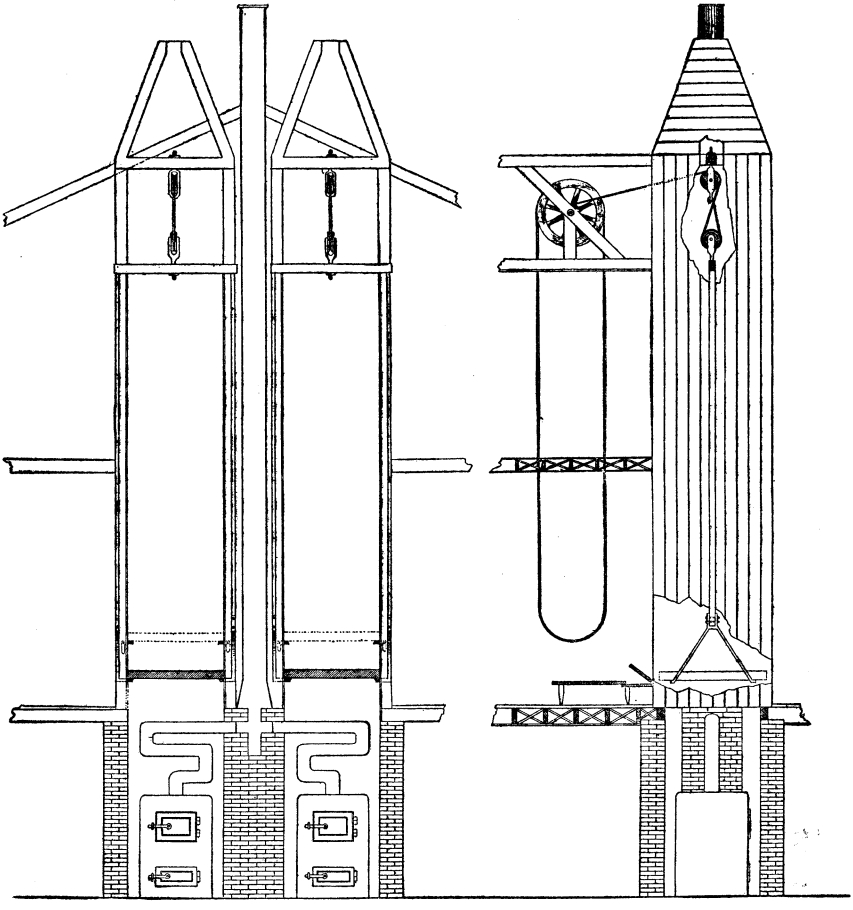

FIG. 15.—General construction of a twin flue evaporator.

so that when a new screen is added at the bottom one must be removed at the top, the operation of manipulating two flues and spreading the fruit is a sufficient task to keep a single individual occupied the entire time. It is necessary, as will be observed from the construction of this device, to make a trip from the second to the third story each time a new screen is added, in order that one carrying dried fruit may be removed at the top.

The opening from which the screens carrying the dried fruits are removed is usually about 4 feet above the floor of the third story. If the stories are 10 feet high, this makes the distance between the point where the screens carrying the fresh fruits enter the shaft and the point where the screens carrying the dried fruits are removed about 12 feet.

The one drawback to this type of evaporator which has always impressed itself upon the writer is that the steam and vapor from the fresh fruits which are placed in the bottom, which is also the most intensely heated portion of the flue, all pass through the fruits which are partially dried on the screens above. It is a more or less common complaint among operators that upon some days when atmospheric conditions are of a certain character not easily described, the process of evaporation, even under the best of management, can not be successfully carried on. The operators say the air is dead and that the fruits will only come to a certain stage of dryness and remain in that condition without reaching the point where they can be removed from the shaft.

It has always been the conviction of the writer that the correct principle for the construction of a shaft evaporator is one which works in exactly the opposite direction from that now employed—that is, a shaft which shall be arranged so that the fresh fruits go in at the top, where the heat is least intense and where the atmosphere is most charged with moisture, and come out at the bottom, nearest the fire, where the air is driest. While it is possible that the temperature at the top of the shaft would not be sufficient to break down the cellular structure of the fruit and produce the desirable conditions which are now secured by placing it directly over the heat, experience with the cabinet evaporator described farther on proves that the principle is correct. The chief reason why the shaft is now operated as it is, is the lack of adequate means for lowering the frames. This can be accomplished by providing a spring clutch at the base of the lifting arm which is forced into position under the second tray from the bottom as the lifting device is drawn upward. The lifting motion should then be continued long enough to raise the column of trays in the shaft so as to release the one which rests at the bottom and immediately over the fire. When this is withdrawn and the apparatus is allowed to adjust itself, the weight of the trays carried by the lifting device will hold the spring clutch in position until the tray or screen to which it is engaged comes in contact with the ways at the bottom of the shaft. As soon as the weight of the trays is taken off the lifting device, the clutch will be released so that it will engage the second tray above, when the operation of lifting is gone through with again. It is

believed that this method of operating the shaft will overcome the difficulty experienced when the atmospheric conditions are not favorable to the use of the present method. It is also believed that this construction will enable the operator to carry the fruit more quickly through the process of drying.

Cabinet evaporator.—For want of a better name, the writer has used the term "cabinet evaporator" to describe a style of evaporator which

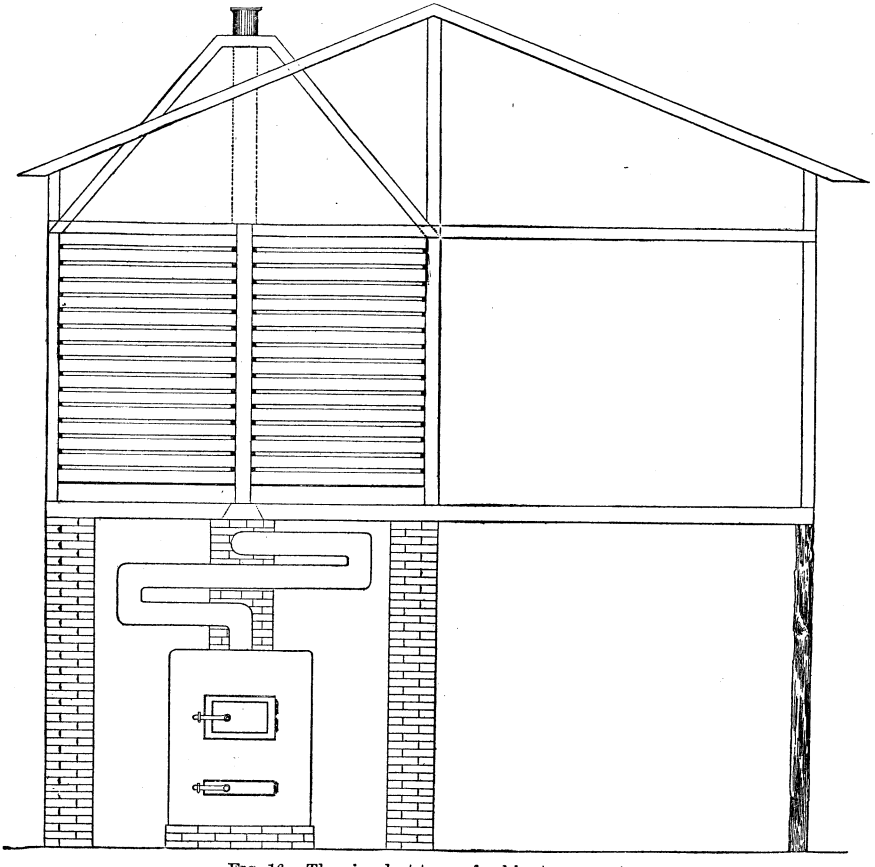

FIG. 16.—The simplest type of cabinet evaporator.

is used by a number of small growers. This evaporator is constructed, as shown in figure 16, of a series of loose drawers (the screens) upon which the fruit is spread prior to the beginning of the operation of drying. The mechanism of the evaporator is very simple, consisting, as shown in the illustration, of a stove or hot-air furnace placed in the basement room, with the top of the furnace 3 feet or more below the lowest screen in the cabinet; the pipe from the furnace is arranged

in a sort of spiral, being carried around the space below the drying area as many times as the distance between the lowest screen and the top of the furnace will permit, so as to throw off and utilize as nearly as possible all the heat coming from the fuel used in the furnace. The drying portion proper (the cabinet) consists usually of two compartments separated by a $\frac{7}{8}$-inch partition, each compartment being provided with ways for carrying the fruit-laden screens.

The interior space of each one of these compartments is generally made 4 feet wide and 8 feet deep from front to back, so that upon each of the guides or ways, which are provided to carry the screens, there are two screens, one in front of the other. The perpendicular distance between the screens in the cabinet is usually about 4 inches. The screens themselves are $3\frac{1}{2}$ or 4 feet square over all. Screens are also made so that they can be used either side up; the frames are constructed of material about $1\frac{1}{4}$ inches square, so that when 8 pieces are used and properly lapped at the corners they make a double frame. As the wire is placed between the two sets of strips, the screens can be used either side up.

The doors for the cabinets are usually hinged at the bottom, so that when opened they fall across supports which form a counter or rest upon which to place the loaded screens; and the bottom screen when placed upon the door will exactly slide into its proper groove.

The method of operating this cabinet evaporator is as follows: The screens, carrying freshly gathered fruit, are placed in at the top of the cabinet, and as those which are driest and which are immediately over the furnace are removed, those screens in the groove next above are taken out and placed on the one immediately below, each pair of screens in succession being lowered one space. This leaves the top space open and ready to receive two newly spread screens. These compartments are usually made so that they carry about 11 or 12 screens, one above another; that is, the distance from the bottom of the screen immediately over the furnace to the bottom of the uppermost screen is about 44 or 48 inches. This is a convenient height for handling the screens. If they are too high the operator has of necessity to stand upon a stool or to do the work in a very awkward position. When it is necessary to raise the arms above one's head in lifting the heavy screens it becomes very hard work. Convenience of operation, therefore, limits the height of the cabinet.

Another form of cabinet evaporator is illustrated in figure 17, the ground plan of which is shown in figure 18. This cabinet can be opened at both front and back instead of at the front only. The screens pass in at the top, as in the above-described arrangement, but the ways are much longer, so that there are from 6 to 10 screens upon

a single plane. The partition in this cabinet runs in a horizontal position rather than in a perpendicular one, as is the case with the partition in the cabinet arrangement illustrated in figure 16. After the topmost tier has been filled, the first screen having been

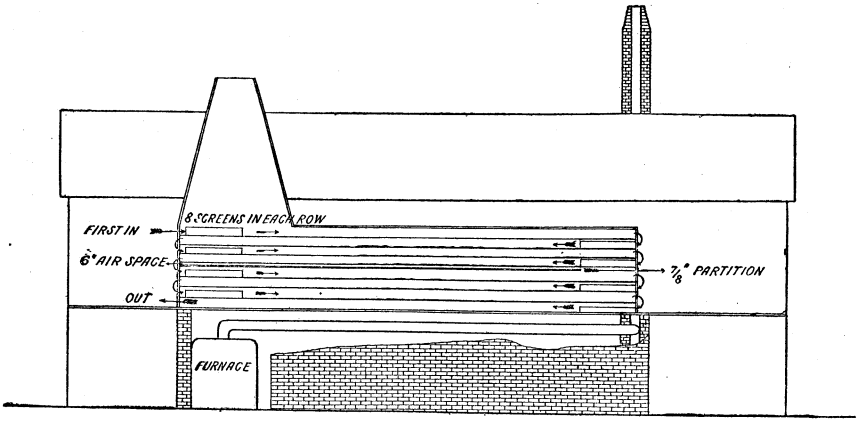

FIG. 17.—Horizontal form of the cabinet evaporator.

pushed farther and farther back as others were put in, the operator takes it out at the rear and immediately places it in the next lower groove, where it is gradually pushed forward, and each screen in turn follows the same course. The cabinet is gradually filled in this way

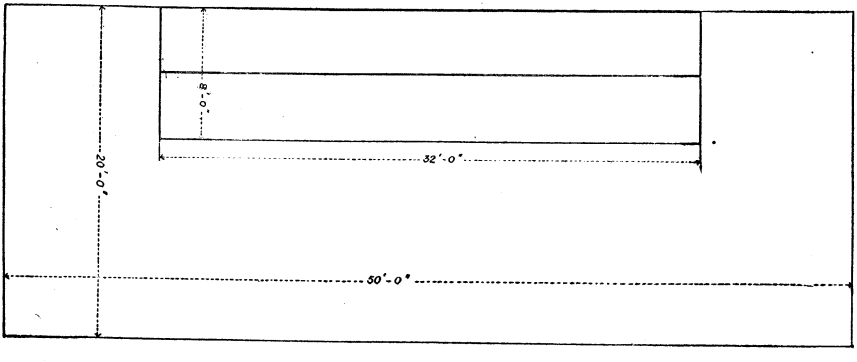

FIG. 18.—Floor plan of figure 17.

as the process of evaporation goes on, and the dried fruits are taken out at the bottom immediately over the fire. The newly spread fruits go into the evaporator at the point farthest away from the fire, underneath the shaft through which the hot air passes out of the cabinet.

This plan of operation, as will be noticed, provides for driving out a portion of the moisture from the newly spread fruits immediately under the hot-air exhaust shaft, while in the case of the shaft evaporators, which raise the screens automatically, the plan of operation is in an exactly opposite direction. Figure 17 of the horizontal cabinet evaporator is sufficiently self-explanatory to need no further description.

HOP-KILN DRIER.

The hop-kiln drier consists of a large furnace room, in the center of which is placed either a large coal stove, a wood stove, or a hot-air

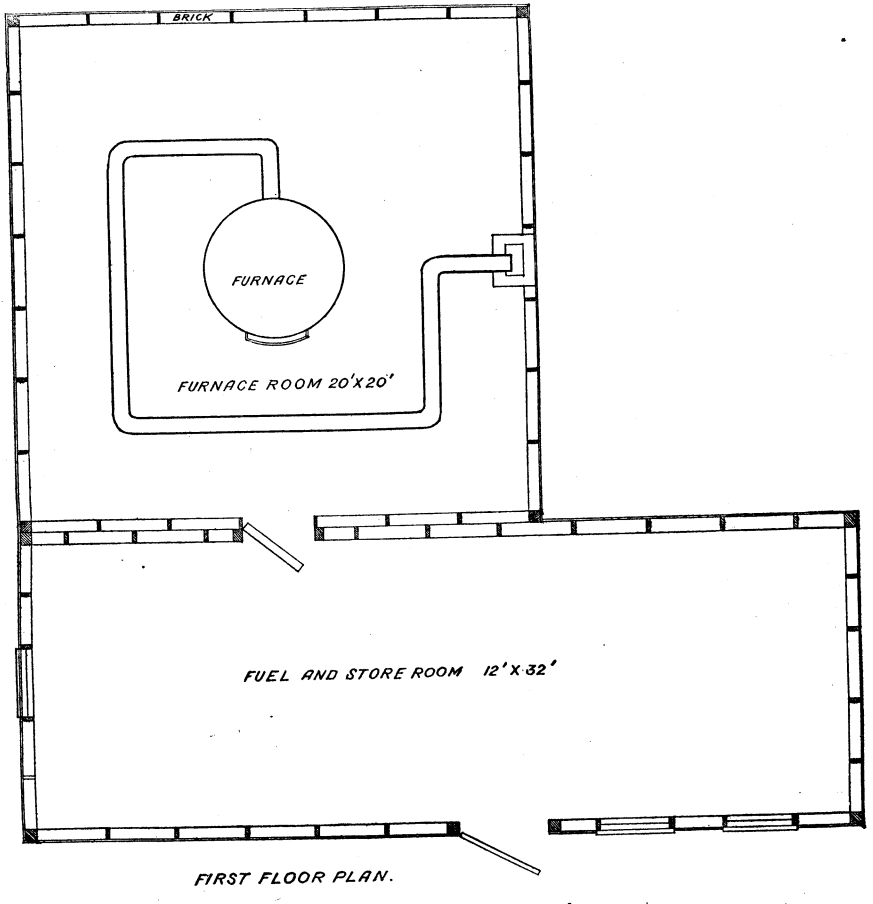

FIG. 19.—First floor plan of hop-kiln type of evaporator.

furnace without a jacket, as shown in figure 19. The pipe from the heater is then carried around the room so as to make at least one complete circuit. The furnace room is usually constructed as follows:

The room is made exactly the same size as the drying kiln, which is to be constructed on the second floor. A common practice is to place 2 by 4 studding 2 feet apart on either a brick or stone foundation, to cover the outside of the building with weatherboarding, and to fill the space between the studs with brick so as to form a 4-inch wall.

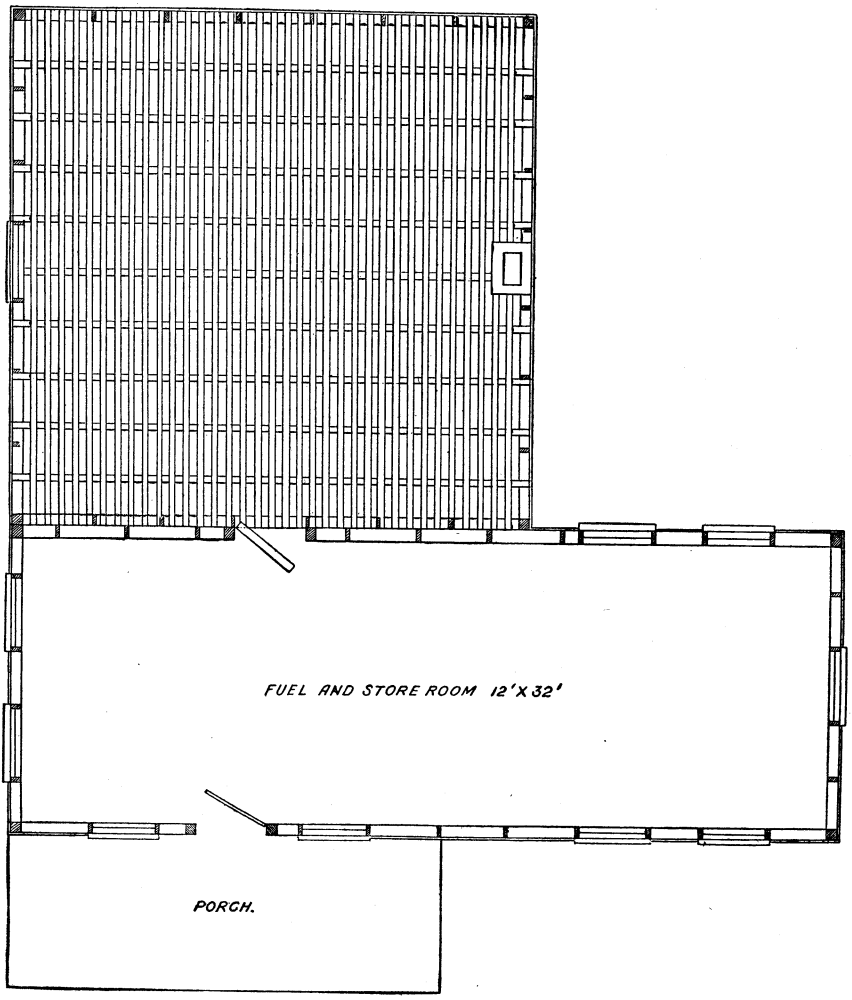

FIG. 20.—Second or dry-room floor of a hop-kiln evaporator.

When it is desirable to avoid this expense, metal laths may be fastened to the inside of the studding and the room plastered so as to make it retentive of heat. If more perfect insulation is desired this can be accomplished by nailing furring strips to the studding so as to admit of placing short pieces of boards in a horizontal position between the studs, thus dividing the space between the clapboards and the lath

and plaster into two chambers instead of into one air chamber. The expense of this construction will, however, in many instances, exceed the cost of the 4-inch brick wall first suggested. These details must, however, be worked out to suit the person who is erecting the drier. Any one of the three methods described will be comparatively satisfactory.

The drying floor, which is usually situated about 10 or 12 feet above the floor of the furnace room, is composed of $\frac{7}{8}$-inch strips, which are carefully spaced, as shown in figures 20 and 21, from $\frac{1}{8}$ to $\frac{1}{4}$ inch apart so

FIG. 21.—Detail of the floor construction of a hop-kiln drier, from below.

as to form cracks or spaces for the passage of the hot air from the furnace room to the chamber above. This chamber is made of sufficient height to admit of carrying on the necessary operations of spreading and stirring the fruit without inconvenience. The ceiling of this room is sometimes made horizontal and sometimes in the shape of an inverted funnel. In all cases, however, sufficient openings are left for ventilation and the building is provided at the comb with openings for allowing the heated air to escape. The exterior construction of such a building is shown in figures 22 and 23.

When the hop-kiln drier is to be used for drying raspberries, apples, or even for the curing of hops, the floor, which is made of strips, as above described, is usually covered with what is called burlap, a rather open cloth, which is strong and will allow the heated air to pass through it easily. In some instances floors constructed with very narrow cracks have no covering of cloth over them, the fruit being spread immediately upon the floor. The common practice, however, is to use the cloth and spread the fruit in sections or upon definite areas from 2 to 4 inches deep, depending upon the character of the fruit to be dried. Raspberries are usually spread about 2 inches deep, while apples may be spread as deep as 4 inches.

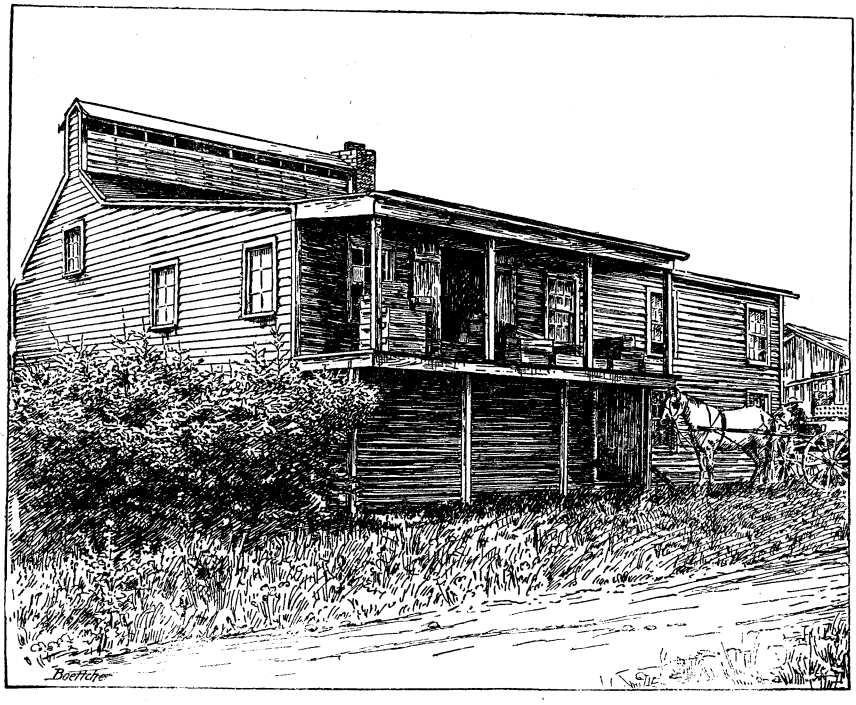

FIG. 22.—Elevation of building, plans of which are shown in figures 19 and 20.

As curing proceeds, the fruits, as soon as they have passed the soft stage which comes on immediately after spreading, are stirred at frequent intervals with a wooden-toothed rake or are turned over with a wooden scoop. As the curing goes on, the depth of the berries decreases, because of the shrinkage from loss of moisture. The area occupied by them is then restricted, so as to keep the drying fruit of considerable depth upon the floor. As the fruit is about to be removed from the drying room several layers are frequently combined so as to occupy very much less space. The fresh fruit, as it comes from the

field, occupies more floor space in proportion to the final product than it does at any stage during the process of evaporation.

When the fruits are sufficiently dried, which may be recognized by their adhering when pressed in the hands, and when there is a small percentage—perhaps 5 or 8 per cent—of comparatively soft fruit in the product, they are ready to go into the curing box or on the curing floor. The fruits are usually removed from the kiln and placed in boxes, which are approximately 2 feet long, 8 inches deep, and 10 inches wide, and hold something less than a bushel. The curing process is completed by daily pouring the fruits from one box to another, thus giving them a chance to become aerated.

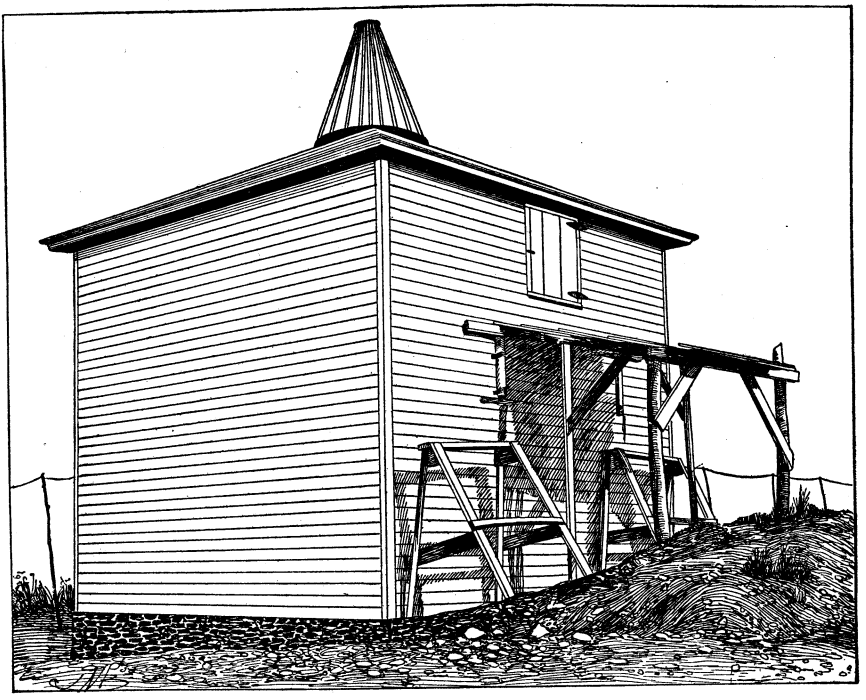

FIG. 23.—Elevation of building in which the floor construction shown in figure 21 is used.

Curing rooms.—In some cases a large floor, something like a miniature malt-house floor, is used for the finishing or curing room. The berries are spread on this floor and frequently stirred with a wooden scoop for several days before they are sacked for market. It is claimed, however, by the advocates of the box system that this is more satisfactory than spreading the berries on the curing floor, as it keeps them in a more confined area and allows those berries which have become too dry in the process of evaporation to take up a small portion of the moisture from the berries which are undercured, thus restoring the

balance between the two, which is an advantage in the finished product. These, however, are matters of experience and judgment, and can not be described with sufficient accuracy to offer a guide to the operator. Experience alone will provide the knowledge which will enable one to determine when the fruit is sufficiently dry to be removed from the kiln.

SUN DRYING.

The drying of berries on racks exposed to the sun is a practice largely in vogue in many of the raspberry-growing regions, and was, up to comparatively recent times, the only method of curing and caring for the fruits of the raspberry. One or the other of the forms of evaporators above described has, however, almost entirely supplanted this primitive method of curing the fruit. This is largely accounted for by two facts: (1) The product of evaporation, properly conducted, is more desirable, and (2) a somewhat larger yield is secured from a given quantity of fresh fruit than can be obtained by the sun-drying process. The method of sun curing is also inconvenient, in that it

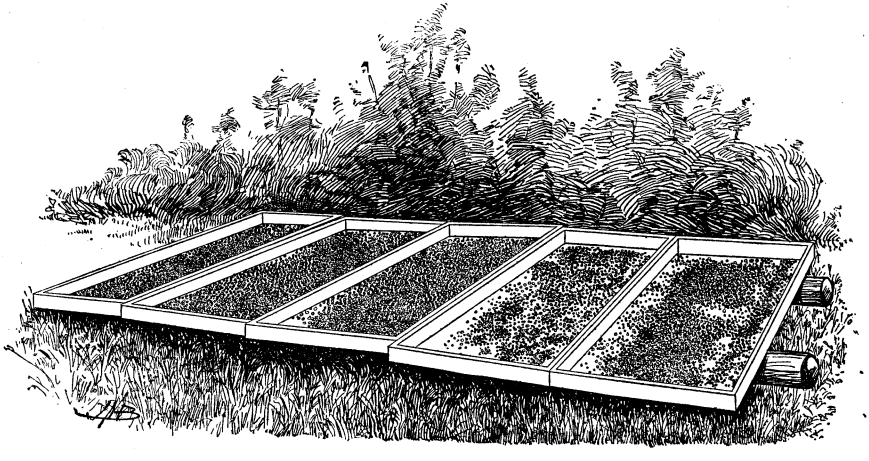

FIG. 24.—Sun drying.

requires a great deal of attention and provision for sheltering the fruit in case of showers, as well as coverings for the racks at night to protect them from rain or dew.

The racks formerly used for drying berries were constructed of ordinary plastering laths, 4 feet long and placed about one-eighth of an inch apart. Over this a thin cloth or paper was spread. Nowadays, however, the drying racks are very generally constructed of light, thin, matched lumber and are very much larger than formerly. The racks are now usually about 3 feet wide and from 6 to 8 or even 10 feet in length. Some growers prefer to use racks about 4 feet square. A set of racks exposed for curing the fruit is shown in figure 24.

QUANTITY AND QUALITY OF THE PRODUCT.

As has already been suggested, the relative quantity of fruit produced by the different methods of curing described varies with the skill of the operator, but it is universally conceded that a larger quantity of

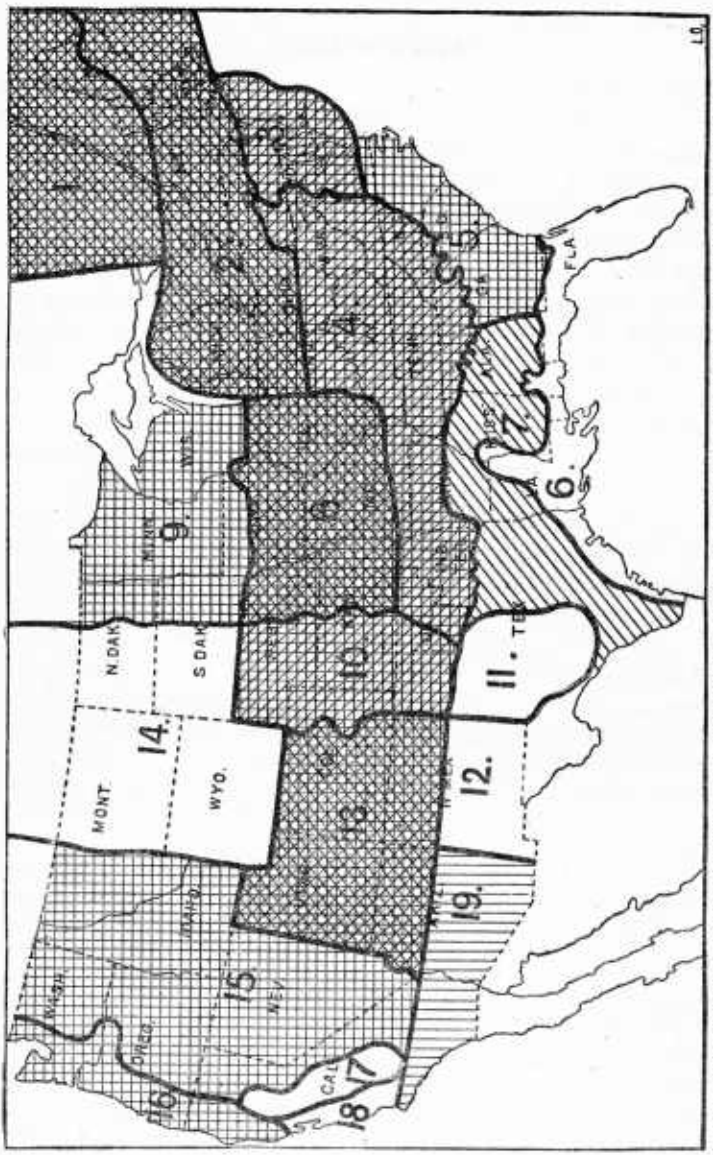

FIG. 20.—Map showing the fruit districts of the United States adapted to raspberry cultivation and the variety or varieties best suited to each district. Rubus idaeus, /; R. neglectus, \; R. occidentalis, —; R. strigosus, |.

marketable product can be secured from a given bulk of fresh fruit when properly cured in an evaporator than when cured by the old method of drying in the sun. A good evaporator product usually commands one or two cents more per pound than the sun-dried fruit.

Ordinarily it is estimated that 3 quarts of fresh fruit will produce 1 pound of evaporated or dried fruit. It is therefore an easy matter for one to estimate the price which must be secured for evaporated fruit in order to put it on the same basis as the fruit sold fresh.

VARIETIES ADAPTED TO EACH FRUIT DISTRICT OF THE UNITED STATES.

The map (fig, 25, p. 34), shows at a glance the localities in which the four types of raspberries, namely, (1) the European raspberry (*Rubus idaeus*); (2) the purple cane (*Rubus neglectus*), which is intermediate between the red and black raspberry; (3) the native black raspberry, or blackcap (*Rubus occidentalis*); and (4) the native red raspberry (*Rubus strigosus*) may be expected to grow and produce profitable crops.

On the map, *Rubus idaeus*, or the European raspberry, is represented by lines which slope downward from right to left; the purple cane, *Rubus neglectus*, by lines which slope downward from left to right; the blackcap, *Rubus occidentalis*, by horizontal lines; and the native red raspberry, *Rubus strigosus*, by perpendicular lines. With this key to the map it is an easy matter to determine the distribution of each group in the United States.

To explain the map more fully and to give prospective growers an idea of the varieties adapted to a particular region, the appended list, arranged according to the commercial importance of the different varieties, as well as according to their botanical classification, has been prepared. The names which are printed in italics are, in all cases, those which are considered best adapted to the region for either culinary or commercial purposes. There is such slight difference in the value of the different sorts of any one group for dessert purposes that it has been deemed unnecessary to separate the list into subdivisions to bring out this point. The italicized names, therefore, may be taken as those which are most productive and most profitable from a commercial standpoint for the locality in which they are mentioned.

DISTRICT No. 1.

European (*R. idaeus*).—*Clarke*, Fastolff, Franconia, Hudson River Antwerp, Orange (Brinckle's Orange), Vermont.

Purple cane type (*R. neglectus*).—*Shaffer*, Philadelphia, Columbian.

Blackcap type (*R. occidentalis*).—*Earhart*, *Gregg*, *Hilborn*, *Ohio*, *Older*, Doolittle, McCormick, Palmer, Souhegan, Lotta, Tyler.

Native red (*R. strigosus*).—*Cuthbert*, *Golden Queen*, *Miller*, Blair, Hansell, Loudon, Marlboro, Turner.

DISTRICT No. 2.

European (*R. idaeus*).—Fastolff, Franconia, Orange (Brinckle's Orange), Vermont.

Purple cane type (*R. neglectus*).—*Columbian*, *Shaffer*, Caroline.

Blackcap type (*R. occidentalis*).—*Conrath*, *Eureka*, *Gregg*, *Hilborn*, *Kansas*, *Nemaha*, *Ohio*, *Palmer*, Cumberland, Doolittle, Lotta, Mills, Older, Souhegan, Tyler.

Native red (*R. strigosus*).—*Cuthbert*, *Golden Queen*, *Loudon*, *Turner*, Brandywine, Hansell, Marlboro, Thwack.

DISTRICT No. 3.

Purple cane type (*R. neglectus*).—Caroline, Columbian, Shaffer.
Blackcap type (*R. occidentalis*).—*Gregg, Kansas,* Cumberland, Doolittle, Hilborn, McCormick, Ohio, Palmer, Tyler.
Native red (*R. strigosus*).—*Brandywine, Cuthbert, Miller.* Golden Queen, Hansell, Kenyon, Loudon, Marlboro, Turner.

DISTRICT No. 4.

Purple cane type (*R. neglectus*).—*Shaffer,* Caroline, Columbian, Reliance.
Blackcap type (*R. occidentalis*).—*Eureka, Gregg, Kansas, Palmer,* Doolittle, Hilborn, McCormick, Nemaha, Ohio, Winona.
Native red (*R. strigosus*).—*Cuthbert, Golden Queen, Loudon, Turner,* Brandywine, Hansell, Kenyon, Miller, Thwack.

DISTRICT No. 5.

Purple cane type (*R. neglectus*).—Shaffer.[a]
Blackcap type (*R. occidentalis*).—Doolittle, Gregg, McCormick, Souhegan, Tyler.
Native red (*R. strigosus*).—*Brandywine, Cuthbert, Golden Queen, Loudon,* Turner.

DISTRICT No. 6.

Not adapted to raspberry growing.

DISTRICT No. 7.

European (*R. idaeus*).—Clarke, Orange (Brinckle's Orange).

DISTRICT No. 8.

European (*R. idaeus*).—Clarke, Orange (Brinckle's Orange), Red Antwerp.
Purple cane type (*R. neglectus*).—*Columbian,* Shaffer, Caroline.
Blackcap type (*R. occidentalis*).—*Eureka, Gregg, Kansas, McCormick, Nemaha, Ohio, Older, Palmer,* Doolittle, Earhart, Lotta, Souhegan.
Native red (*R. strigosus*).—*Cuthbert, Loudon, Thwack, Turner,* Brandywine, Golden Queen, Marlboro, Miller.

DISTRICT No. 9.

Purple cane type (*R. neglectus*).—Columbian.[b]
Blackcap type (*R. occidentalis*).—*Gregg,* Ohio.
Native red (*R. strigosus*).—*Cuthbert, Loudon,* Marlboro, Turner, Miller.

DISTRICT No. 10.

Purple cane type (*R. neglectus*).—*Columbian,* Philadelphia, Reliance, Shaffer.
Blackcap type (*R. occidentalis*).—*Eureka, Gregg, Tyler,* Doolittle, Kansas, McCormick, Nemaha, Ohio, Palmer, Souhegan.
Native red (*R. strigosus*).—*Cuthbert, Marlboro,* Brandywine, Golden Queen, Loudon, Turner.

DISTRICT No. 11.

Not adapted to raspberry growing.

DISTRICT No. 12.

Not adapted to raspberry growing.

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[a] Sparingly grown in this section. Not shown on map.
[b] Not shown on map, as it is less commonly grown than the other two types mentioned.

DISTRICT No. 13.

European (*R. idaeus*).—Fastolff, Franconia, Hudson River Antwerp, Red Antwerp.
Purple cane type (*R. neglectus*).—*Shaffer*, Caroline, Philadelphia, Reliance.
Blackcap type (*R. occidentalis*).—*Gregg*, *McCormick*, *Ohio*, *Palmer*, *Souhegan*, Doolittle, Kansas, Nemaha, Tyler.
Native red (*R. strigosus*).—*Brandywine*, *Cuthbert*, *Marlboro*, *Turner*, Golden Queen, Loudon, Thwack.

DISTRICT No. 14.

Not adapted to raspberry growing.

DISTRICT No. 15.

Blackcap type (*R. occidentalis*).—*Gregg*, *Kansas*, Ohio, Palmer, Souhegan.
Native red (*R. strigosus*).—*Cuthbert*, Golden Queen, Loudon, Marlboro.
Purple cane type (*R. neglectus*).—Shaffer.[a]

DISTRICT No. 16.

Purple cane type (*R. neglectus*).—Shaffer.[a]
Blackcap type (*R. occidentalis*).—*Gregg*.
Native red (*R. strigosus*).—*Cuthbert*, Golden Queen.

DISTRICT No. 17.

Not adapted to raspberry growing.

DISTRICT No. 18.

Not adapted to raspberry growing.

DISTRICT No. 19.

Native red (*R. strigosus*).—*Cuthbert*, Loudon.

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[a] Not indicated on map because it is of secondary importance to the other varieties mentioned.